**EXPERIMENT #5**

An efficient message passing in computer networks, even wireless, is often taken for granted in contemporary solutions. This approach is fully justifiable as long as the nodes in such network are equipped with high performance CPUs and are able to support power-demanding radio devices. However, limiting ourselves to tiny artefacts, such as sensor nodes brings us to the world of microprocessors with limited computation and storage and battery-run radio transmitters. However, the demand for efficient network cooperation, expressed by reliable and timely message passing and possibly long and uninterrupted lifetime of the system remains.

The hardware limitations are reflected in many constraints that need to be taken into account in developing operation algorithms for wireless sensors and their evaluation in simulations and real-world testbeds. In this fine-grain scale of low power radios come to play such phenomena as radio propagation asymmetry and signal fading, for which a general mathematical model for all possible scenarios of deployment is not possible. Simulations allowing for some level of generalization are needed here, followed by in-field testing. Similarly, wireless communication combined with high limitation on energy consumption result in the need for careful design of media access and message passing protocols. The maximal limitation of failed attempts to transmit on the one hand and assuring of fair and robust access to radio channel on the other often result in probabilistic models, to which particular parameters need to be selected for real-world applications.

As some sensor networks may be deployed inside buildings it seems vital to estimate what impact on communication protocols inside such network can have installations and construction of the building itself. We have conducted an introductory experiment to reflect perturbations in communication between a node and a base station in confined area. Preliminary analysis using Mica2 boards reveal strong perturbations of RSSI (Received Signal Strength Indication) factor in a relatively simple setting of a straight, empty corridor. Moreover, the aberrations do not reveal any standard fade-out pattern but seem strongly correlated with placement of heaters and windows along the corridor. These observations cast different light on the analysis of protocols that employ standard (eg. unit circle or ROI) models of propagation: transmission of a message incurs a power loss not only dependent on the distance, but also on the relative placement of the two transmitting units and surrounding environment.

The measurements conducted thus far leave ample room for improvement. Firstly, the manifestations of failed communication (collisions, repetitions, fade-outs, hidden terminals etc.) can be studied more closely by investigating the radio emanation, rather than node-generated transmission reports. We are going to use USRP (Universal Software Radio Peripheral) to investigate the whole communication at closer scale of physical phenomena. Secondly, the same investigation must be made for greater number of nodes. For inter-node communication as well as message routing to and from the base station increased "congestion" in the radio channel and hence further asymmetry in power propagation.

Other simulations and implementations will include an alarm protocol that we have recently developed. There, we considered a single-hop network of nodes that go into power-saving sleep mode in arbitrary moments. At the same time, their aim is to send an alarm message to the base station the moment the event (such as fire, contamination etc.) occurs. Due to physical nature of the event we assume that more than one sensor at the same time can trigger to transmit. To avoid collisions, and hence fail to raise the alarm, we propose that each node willing to transmit uses a constant number of trials within a given time interval and attempts to access the channel in each trial with exponentially decreasing probability.

The aim of the simulation is to discover practical, in terms of timeliness of the alarm, parameters of the protocol: the number of trials and the length of the interval, with respect to the number of active and sleeping nodes. With these experimental values it will be possible to implement the protocol in real hardware and verify the validity of the concept.

To sum up, it should be noted that many theoretical works in the field of protocols for sensor networks should have their verification phase run in versatile simulation and real-world scenarios. Due to special character of these devices, there are intrinsic properties of each deployment that can influence the effectiveness of the proposed idea. Among many, such factors as conditions of radio propagation and natural properties of the phenomenon measured by the sensors cannot be faithfully represented in theoretical considerations. First results show that where theory meets practical implementation, special care must be taken to allow for these intangible parameters.